

Prevalence and Determinants of Diarrhea among Under Five Years Children in Musanze District

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Abstract

Background

Diarrheal disease remains a significant public health issue worldwide, especially among children under five in low- and middle-income countries like Rwanda. Despite improvements in water and sanitation infrastructure, diarrhea prevalence among young children in Rwanda remains high, with Musanze District in the Northern Province being one of the most affected areas.

Objective

This study investigated the prevalence and determinants of diarrhea among children under five in Musanze with emphasis on household-level factors such as water treatment, sanitation, and maternal practices.

Methods

A cross-sectional quantitative study was conducted involving 206 mothers and caregivers from Ruhengeri Referral Hospital and 17 health centers, selected through cluster sampling. Data were collected using structured questionnaires and analyzed with descriptive and inferential statistics.

Results

The study found an overall diarrhea prevalence of 20.39%, with urban areas experiencing a higher prevalence (33.93%) than rural areas (15.33%), a statistically significant difference ($\chi^2 = 8.69$, $p < 0.01$). Key risk factors included the presence of feces around households (OR = 27.507, $p < 0.01$), feces near pit latrines (OR = 4.691, $p < 0.05$), and larger family sizes (OR = 9.026, $p < 0.05$). Protective factors included higher socioeconomic status, maternal education, private latrine ownership, water treatment practices and living in urban areas.

Conclusion

the study underscores the persistent burden of diarrhea in Musanze and identifies critical household and environmental determinants. Targeted interventions addressing these factors could significantly reduce diarrhea prevalence in this region.

1. Introduction

Diarrheal disease remains a substantial global public health challenge, disproportionately affecting children under five years of age in low- and middle-income countries (LMICs) (Thystrup et al., 2024). Approximately, it accounts for one in every nine child deaths worldwide and continues to represent the second leading cause of mortality among children under five years (Hartman et al., 2023). According to world health organization (WHO) in 2024 data shows that diarrheal diseases are responsible for approximately 1.8 million cases annually in children under five[1]. In addition, United Nations International Children's Emergency Fund (UNICEF) in 2024, indicates that in a year of 2021 alone, diarrhea led to over 444,000 child deaths, contributing to 9% of all under-five mortality globally [2].

Diarrhea contributes to significant health complications including malnutrition, dehydration, and hospitalizations. This further imposes an economic burden on families and health systems. A systematic review conducted by Baral *et al.* (2020), estimated the mean economic burden of pediatric diarrhea to be approximately \$36.56 per outpatient episode and \$159.90 per inpatient episode, with direct medical costs constituting the largest proportion of the total expenditure[3]. This could imply that diarrheal illness strain household finances, potentially limiting access to timely healthcare and reinforcing existing socioeconomic vulnerabilities. It also deepens our understanding of the interplay between health and economic stability, illustrating how disease burden can perpetuate cycles of poverty and health inequity.

Dehydration, a complication of diarrheal disease caused by fluid loss, presents with signs such as reduced urine output, dry mouth and tongue, unresponsiveness, sunken or glazed eyes, fatigue, and in severe cases, confusion[4]. Treatment involves intravenous fluids, oral rehydration therapy, and addressing the underlying cause[4]. Other complications of diarrhea mentioned include the spread of infection to bones and joints especially with salmonella infections, hemolytic uremic syndrome, electrolyte imbalances, irritable bowel syndrome, lactose intolerance, and malnutrition[4].

In LMICs, diarrhea is intensified by preventable risk factors such as unsafe drinking water, inadequate sanitation, and poor hygiene practices[5]. Specifically, Sub-Saharan Africa and South Asia bear the brunt of these fatalities, with more than 80% of deaths due to diarrheal diseases[6]. A recent systematic review by Ugboko *et al.*, (2020), highlights the disproportionate vulnerability of children in these settings, where access to clean water and affordable healthcare services remains limited[7]. On the same note, Azanaw *et al.* (2024), reported that number of children under five in household, maternal occupation, economic status and disposal of young children's stools were associated with diarrhea [8].

In the East African region, countries such as Ethiopia and Tanzania have reported a high prevalence of diarrheal diseases among children. For example, a study conducted in Simada Woreda, Ethiopia, demonstrated a prevalence rate of 14.5% (Feleke et al., 2022), while Mwanza, Tanzania showed 20.4% among children aged between 6 and 59 months[9]. These statistics highlight the regional disparities in child health outcomes.

In Rwanda, diarrheal disease remains a public health concern despite commendable improvements in access to clean water and sanitation and increased vaccine coverage. For instance, the 2019–2020 Rwanda Demographic and Health Survey (RDHS) indicates that 14% of children under five experienced

diarrhea, with higher prevalence in rural areas compared to urban areas[10]. Notably, Northern Province recorded the highest regional prevalence (16%), and Musanze District ranked among the top three districts with a rate of 17%[11]. However, there is no study that has been conducted in Musanze to assess the determinants of diarrhea among children under five. Therefore, this study aims to identify and analyze the local risk factors contributing to the high prevalence of diarrhea in Musanze District, with the goal of informing targeted and context-specific interventions

2. Methodology

2.1. Research design

This study employed a cross-sectional, quantitative research design to examine the prevalence and factors influencing diarrheal diseases among children under five years old in Musanze District, Rwanda. A cross-sectional design was chosen because it enables data collection at a single point in time, providing a clear picture of the current situation. This approach allowed the study to analyze patterns, associations, and potential risk factors affecting the occurrence of diarrheal diseases within the selected population. By using a quantitative method, the study ensured objective measurement and statistical analysis of the data. The representative sample was carefully selected to reflect the broader community, enhancing the study's reliability and generalizability. This method helped identify key factors that could inform health policies and interventions.

2.2. Study area and Sample size design

Musanze District, in Rwanda's Northern Province, has 476,522 residents, making up 23.4% of the province's population (NISR, 2023). It spans 15 sectors, 68 cells, and 432 villages, with a high density of 1,157 people/km². The majority of its population is young, with 57% under 25 years (NISR, 2023). Nearly equal urban (49.2%) and rural (50.8%) populations. Agriculture dominates, employing about 66.3% of households. Education levels vary, with 45% of youth completing primary school. Most residents have access to improved water sources, though sanitation challenges persist. Health concerns for children under five include diarrhea (17% prevalence), acute respiratory infections, and anemia [10]. Waste disposal remains an issue, with 33.6% dumping in fields or bushes (NISR, 2023).

This study focused on mothers and caregivers of children under five years old who were receiving healthcare services. The study sites included Ruhengeri Referral Hospital and 17 surrounding health centers. A cluster sampling method was used, with each health facility forming a cluster. A total of 206 participants were systematically selected. The selection was done using proportional allocation based on the average number of children under five served at each facility every month. The sample size was determined using the Fisher's formula, with an additional 10% included to account for possible non-response. This approach ensured a representative sample for accurate findings.

2.3. Data sources and analysis

The data for this study were collected using a structured questionnaire that was carefully designed and translated into local language 'Kinyarwanda' for better communication between research assistants and respondents. The questionnaire included questions on demographic, socioeconomic, and environmental factors to ensure comprehensive data collection. Before the main survey, one day pilot test was conducted to assess the validity and reliability of the questionnaire. Based on the pilot results, minor adjustments were made to improve the clarity of the questions. The data collection process was supervised by the researchers to ensure accuracy and completeness.

For the purpose of data analysis, both descriptive and inferential statistical methods were applied. Descriptive statistics were used to summarize demographic characteristics of the respondents. Inferential statistics, specifically the logit model, were employed to identify the factors influencing diarrhea among children under five years old. Additionally, Chi-square tests were used to examine associations between independent variables and the prevalence of diarrhea. Statistical significance was determined using a p-value threshold of 0.05, meaning that variables with a p-value below this level were considered to have a significant influence. This approach ensured a detailed understanding of the relationships between different factors and the occurrence of diarrhea in young children.

In this study, the analysis was at household level. The households were classified based on whether they had at least one child under five years old who has suffered from diarrheal diseases. A household with such a case were assigned a numeric 1, indicating the presence of the attribute while those without served as the benchmark with a value of 0. The model helped determine the likelihood of a household having a child affected by diarrheal diseases. The selection of explanatory variables was fully based on previous studies relevant to the current work. Following Mengistie, Berhane, and Worku, (2013); Omona et al., (2020); and Adam Birhan et al., (2024), the binary model is deemed the most appropriate for this study[13]–[15]. Consequently, a binary logistic regression model was employed in accordance with the methodological framework outlined by Gujarati (2004) [16].

$$Li = \ln \left(\frac{P_i}{1 - P_i} \right) = Z_i = \beta_0 + \beta_i X_i + \mu_i$$

Where L_i stand for log of the odds ratio; P_i denotes the likelihood of the i^{th} household had at least one child under five years old who has suffered from diarrheal diseases and $1 - P_i$ is the likelihood of the household had no child under five years old who has suffered from diarrheal diseases; X_i stands for the variables that influence diarrhea among under five years old and μ_i is error term that captures all other variables that not considered which might have influence on diarrhea prevalence among under five years old.

$L_i = \ln \left(\frac{1}{0} \right)$ if a household had at least one child under five years old who has suffered from diarrheal diseases.

$L_i = \text{Ln} \left(\frac{0}{1} \right)$ if a household had no child under five years old who has suffered from diarrheal diseases.

3. Results and discussion

3.1. Socio-demographics of the respondents by residence

Table 1 below presented the demographic characteristics of respondents. It is clear that the overall prevalence of diarrhea among children under five in the study area was 20.39%. Urban areas had a significantly higher prevalence (33.93%) compared to rural areas (15.33%). The prevalence difference by location was statistically significant ($\chi^2 = 8.69$, $p < 0.01$). With regard to Ubudehe category (socioeconomic classification), Category 1 (poorest) were more prevalent in urban areas (19.64%) than rural (5.33%), showing significant difference ($\chi^2 = 14.22$, $p < 0.001$). Furthermore, households with only one child were more common in rural areas (78.67%) than in urban areas (66.07%) ($\chi^2 = 3.47$, $p < 0.05$). Whereas, other factors like sanitation (presence of faeces around house and pit hole, latrine ownership), mother's occupation, and family size showed no significant difference between urban and rural areas.

Table 1
Demographic characteristic of the respondents

Variable	Residence		Combined (n = 206)	Significant difference (chi ²)
	Urban (n = 56)	Rural (n = 150)		
Experience diarrhea	33.93	15.33	20.39	8.69***
Ubudehe Category				
Category 1	19.64	5.33	9.22	14.22***
Category 2	60.71	54.67	56.31	
Category 3	19.64	40.00	34.47	
feaces around HH	33.93	32.00	32.52	0.07
feaces pit hole	50.00	54.67	53.40	0.36
Family size				
2–4	71.43	62.00	64.56	1.58
5+	28.57	38.00	35.44	
Age of the child in month				
1–12 months	25.00	36.67	33.50	2.71
13–24 months	62.50	54.67	56.80	
25–36 months	12.50	8.67	9.71	
# of children under 5 in HH				
One child	66.07	78.67	75.24	3.47*
Two and above	33.93	21.33	24.76	
Occupation				
Farmer	50.00	41.33	43.69	2.30
Jobless	35.71	35.33	35.44	
Off-farm worker	14.29	23.33	20.87	
Mather's educated	58.93	48.00	50.97	
Owning latrine				
Shared	25.00	25.33	25.24	0.00

Variable	Residence		Combined (n = 206)	Significant difference (chi ²)
	Urban (n = 56)	Rural (n = 150)		
<i>Private</i>	75.00	74.67	74.76	
Make water for drinking safer				
<i>Nothing</i>	50.00	54.00	52.91	0.26
<i>Any other means</i>	50.00	46.00	47.09	

HH stand for household, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

3.2. Factors associated with diarrhea disease

A logistic regression model was used to identify significant predictors of diarrheal disease. The identified factors that increase the likelihood of diarrhea include presence of feces around the household, seeing faeces around a pit latrine, larger family size. These three factors have a positive association with diarrheal prevalence and they were statistically significant at 1% level. The results of this study also revealed the protective factors that reduce the likelihood of diarrhea and they were the following higher Ubudehe categories (better socioeconomic status) Category 2 (OR = 0.011, $p < 0.001$) and Category 3 (OR = 0.076, $p < 0.01$), children aged 13–24 months had significantly lower odds than those aged 1–12 months (OR = 0.204, $p < 0.05$), mother's education where educated mothers had children with significantly reduced odds of diarrhea (OR = 0.228, $p < 0.1$), private latrine ownership showed strong protective effect (OR = 0.023, $p < 0.001$) and treating drinking water also associated with reduced risk (OR = 0.290, $p < 0.1$). Lastly, urban residence reduced odds compared to rural areas after controlling for other factors (OR = 0.439, $p < 0.05$), despite the crude prevalence being higher in urban areas.

Table 2
Multivariate logistic Regression

Variable	Robust Marginal effect	Z	Robust Odds ratio	z
Ubudehe category (<i>bench mark = Category 1</i>)				
Category 2	-0.389 *** (0.070)	-5.580	0.011*** (0.014)	-3.510
category 3	-0.297*** (0.072)	-4.120	0.076** (0.088)	-2.220
faece_arround_HH	0.104*** (0.027)	3.900	27.507*** (24.954)	3.650
faece_pithole	0.021 (0.040)	0.540	4.691** (3.135)	2.310
family_size_cat	0.015 (0.040)	0.380	9.026** (7.354)	2.700
Age (<i>bench mark = 1–12 months</i>)				
13–24 months	-0.102*** (0.028)	-3.570	0.204** (0.158)	-2.050
25–36 months	0.082 (0.076)	1.080	2.702 (2.434)	1.100
number_under_five	-0.161** (0.082)	-1.970	0.444 (0.440)	-0.820
occupation_mother (<i>bench mark = farmer</i>)				
Jobless	-0.001 (0.027)	-0.030	3.147 (2.519)	1.430
Employed in offfarm	-0.036 (0.036)	-1.010	1.279 (1.102)	0.290
Residence_under_five	-0.071** (0.035)	-2.060	0.439 (0.496)	-0.730
Education_mother	-0.071**	-2.740	0.228*	-1.760

Variable	Robust	Z	Robust	z
	Marginal effect		Odds ratio	
	(0.026)		(0.191)	
latrine_own	-0.164*** (0.024)	-6.790	0.023*** (0.021)	-4.100
make_water_safer	-0.060** (0.029)	-2.080	0.290* (0.187)	-1.920
Number of obs	206		206	
Pseudo R ²	0.7602			
Wald chi2(14)	50.87***		67.29***	
Log pseudolikelihood	-24.986873		-35.457155	

Standard errors in the parenthesis, *** p < 0.01, ** p < 0.05, * p < 0.1

3.3 Results and Discussion

The study conducted in Musanze District, Rwanda, revealed a prevalence of diarrheal diseases among children under five years old at 20.39%, with a significantly higher prevalence in urban areas (33.93%) compared to rural areas (15.33%). This finding aligns with recent studies in sub-Saharan Africa, where urban-rural disparities in diarrhea prevalence are often attributed to differences in sanitation infrastructure and population density. For instance, a 2021 study in Ethiopia reported a higher prevalence of diarrhea in urban settings due to overcrowded living conditions and inconsistent access to clean water (Demissie et al., 2021). However, the logistic regression results in this study indicate that, after controlling for other factors, urban residence was associated with reduced odds of diarrhea. This suggests that urban areas in Musanze may have better access to healthcare facilities or improved water treatment practices, which mitigate diarrhea risk when other variables are accounted for.

Key risk factors identified include the presence of feces around the household and around pit latrines (OR = 4.691, p < 0.05), as well as larger family sizes. These findings are consistent with recent literature highlighting the role of poor sanitation and hygiene practices in increasing diarrhea risk. For example, a 2022 study in Tanzania found that improper fecal disposal significantly increased the likelihood of diarrheal diseases among children under five[9]. Similarly, larger family sizes have been associated with higher diarrhea prevalence due to increased exposure to pathogens and strained household resources, as noted in a 2020 study in Uganda[14].

Protective factors included higher socioeconomic status namely ubudehe Categories 2 and 3, maternal education, private latrine ownership and treating drinking water. These findings corroborate evidence from recent studies emphasizing the protective role of improved socioeconomic conditions and hygiene

practices. For instance, a 2024 study in Ethiopia found that households with educated mothers were less likely to report child diarrhea due to better health knowledge and caregiving practices[8]. Similarly, access to private latrines and water treatment has been shown to reduce diarrhea risk by limiting exposure to contaminated environments, as reported in a 2021 systematic review[17].

The age of the child also played a significant role, with children aged 13–24 months having lower odds of diarrhea compared to those aged 1–12 months. This may reflect the protective effects of breastfeeding and the introduction of complementary feeding, which strengthen immunity, as supported by a 2019–2020 demographic health survey in Rwanda highlighting the role of optimal feeding practices in reducing diarrhea incidence[18]. However, no significant association was found for children aged 25–36 months, possibly due to increased environmental exposure as children become more mobile. Lastly, while crude prevalence was higher in urban areas, the adjusted odds suggested a protective effect of urban residence. This discrepancy may be explained by unmeasured factors such as better access to health education or vaccination programs in urban settings.

4. Conclusion and recommendations

This study demonstrates the persistent burden of diarrheal diseases among children under five in Musanze District. The identified risk factors include presence of feces around households and pit latrines, and larger family sizes emphasize the critical role of poor sanitation and hygiene practices in driving diarrhea prevalence. Conversely, protective factors such as higher socioeconomic status, maternal education, private latrine ownership, and water treatment practices significantly reduce the likelihood of diarrhea, highlighting the importance of socioeconomic and behavioral interventions. The lower odds of diarrhea in children aged 13–24 months suggest the protective role of breastfeeding and complementary feeding practices. The unexpected protective effect of urban residence after adjusting for other factors may reflect better access to healthcare and health education in urban settings.

These findings provide valuable insights into the local determinants of diarrhea, offering a foundation for evidence-based public health strategies to mitigate this preventable disease. These results also emphasize the need for targeted interventions focusing on improving sanitation infrastructure, promoting maternal education, and supporting households in adopting safe water and hygiene practices. Such strategies are critical in reducing the disease burden and improving child health outcomes in Musanze District and similar contexts.

Declarations

Ethics approval and consent to participate

Ethical approval for this study was obtained from the University of Rwanda- College of medicine and health sciences Institutional Review Board with reference number CMHS/IRB/071/2024 which was dated 15/01/2024. The study was conducted in accordance with the principles of the Declaration of Helsinki.

Written informed consent to participate was obtained from all participants prior to data collection. For children under five years of age, consent was obtained from their parents or legal guardians.

Consent for publication

Not applicable

Availability of data and materials

The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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The study received no external funding.

Authors contribution

All authors have contributed to the study. JBN was the one who designed the study protocol, searched articles for the literature review, conducted data collection, performed all analyses and results interpretation, drafted the manuscript, and represented as the corresponding author. VH, SS, AN, and FXN contributed to the protocol preparation, reviewing, and revising the manuscript. SG and FN helped in revising the manuscript and providing inputs for finalizing the manuscript. All authors read and approved the final manuscript.

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